

Fixation of the Distal Radius Fractures – Is it Safe to Start Moving?

Miguel A. Pirela Cruz, M.D., F.A.C.S.

Professor of Orthopedic Surgery

Paul L. Foster School of Medicine

Department of Orthopaedic Surgery & Rehabilitation

El Paso, Texas



TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER™
EL PASO



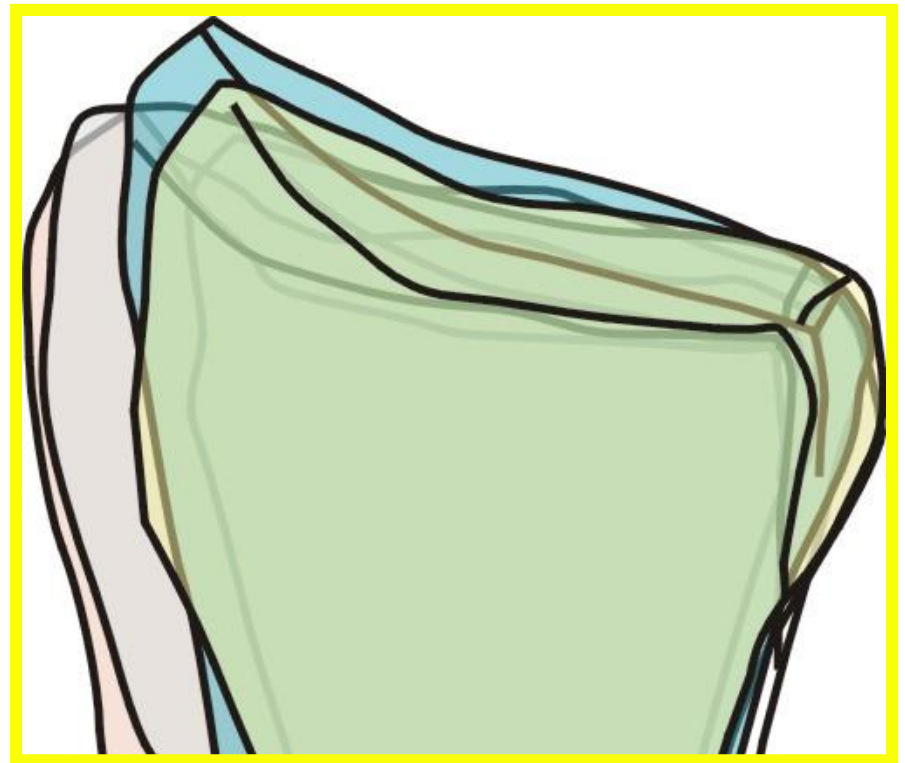
Objectives

1. Understand how distal radius fractures are classified
2. Understand the various types of fixation
3. To determine if a fracture is stable after treatment (and safe to move)
4. Review complications associated with surgical treatment

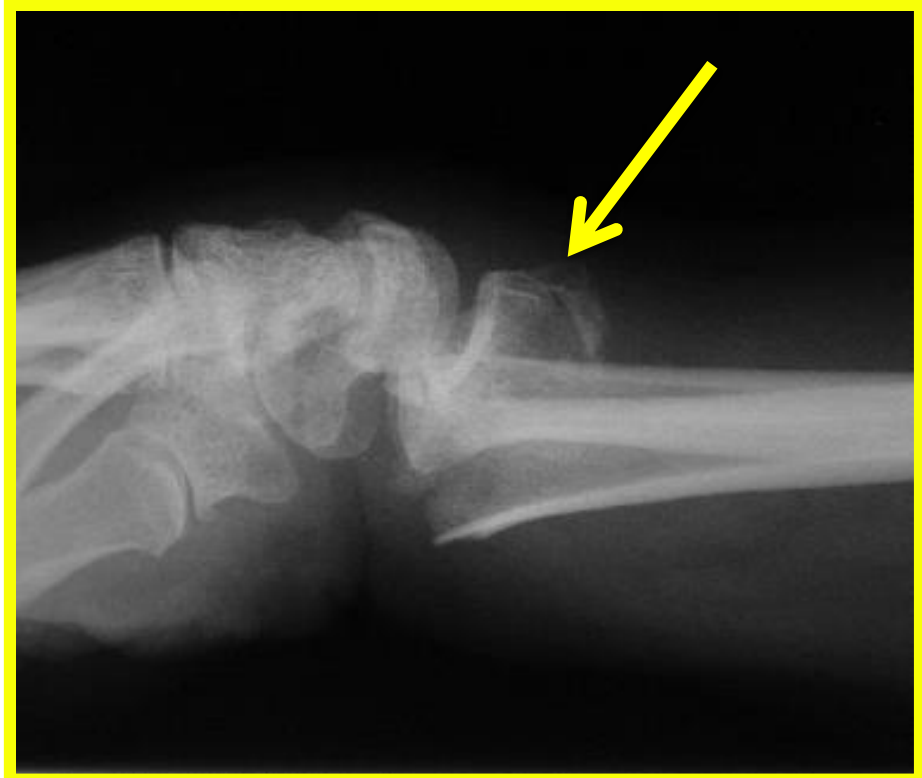
Anatomy (Distal Radius)

Three independent articular surfaces:

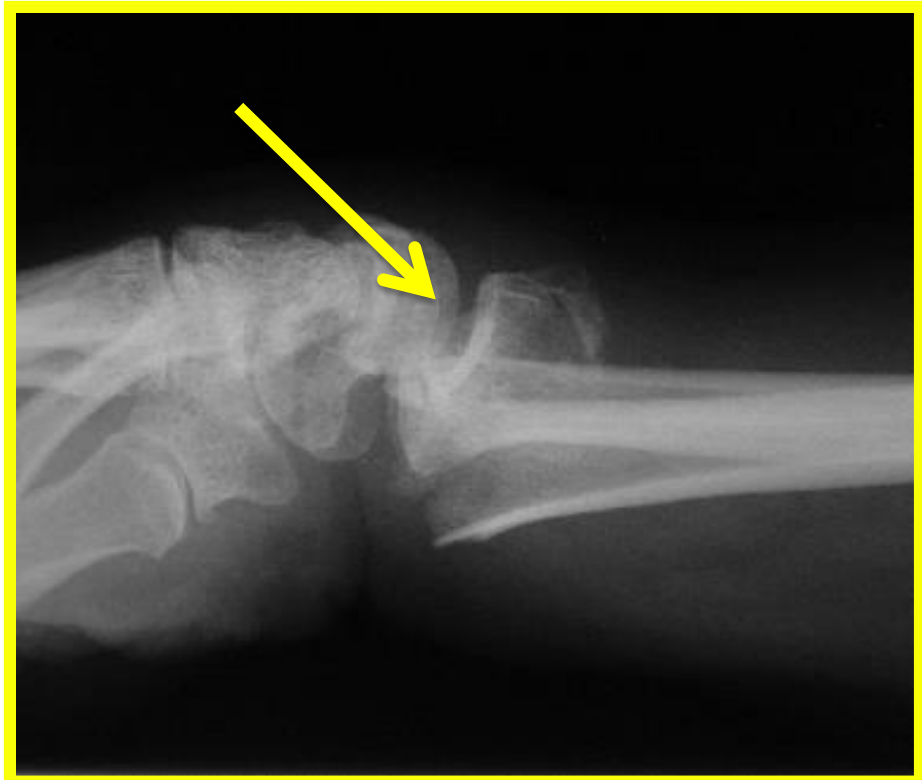
- Scaphoid facet
- Lunate facet
- Sigmoid facet



DRF: Dorsal Displacement



DRF: Reversal of the Palmar Tilt

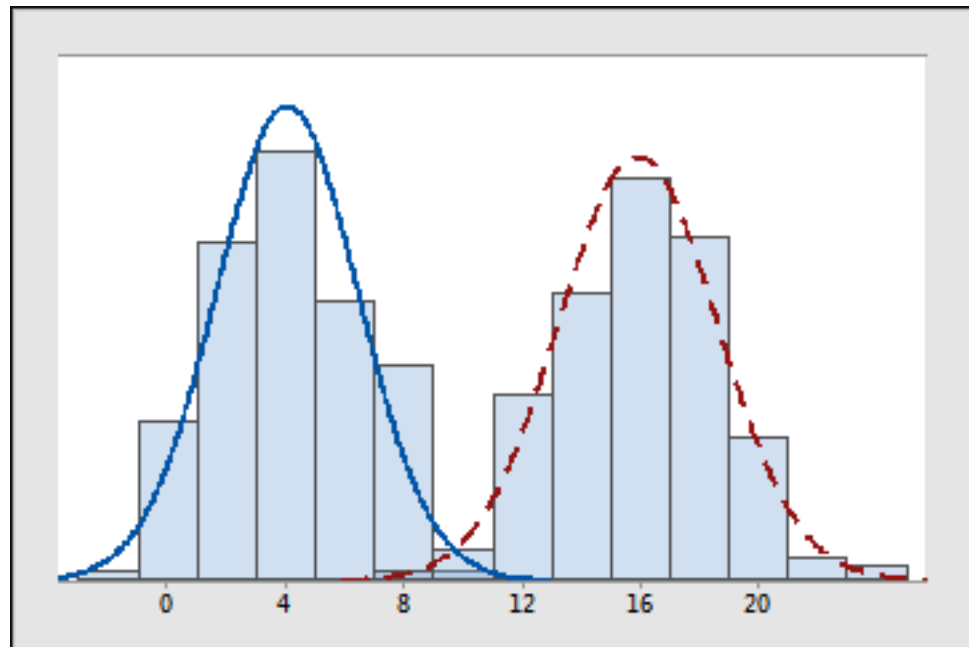


DRF: Disruption of DRUJ



Introduction

- DRF's most common orthopaedic injury with a bimodal distribution
 - younger patients - high energy
 - older patients - low energy / falls



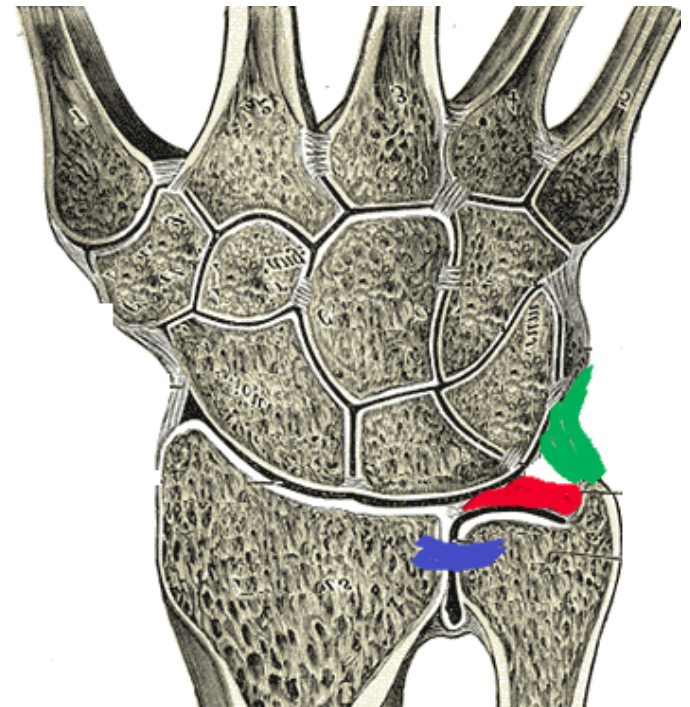
Introduction

- Most common orthopaedic injury with a bimodal distribution
 - younger patients - high energy
 - older patients - low energy
- 50% intra-articular



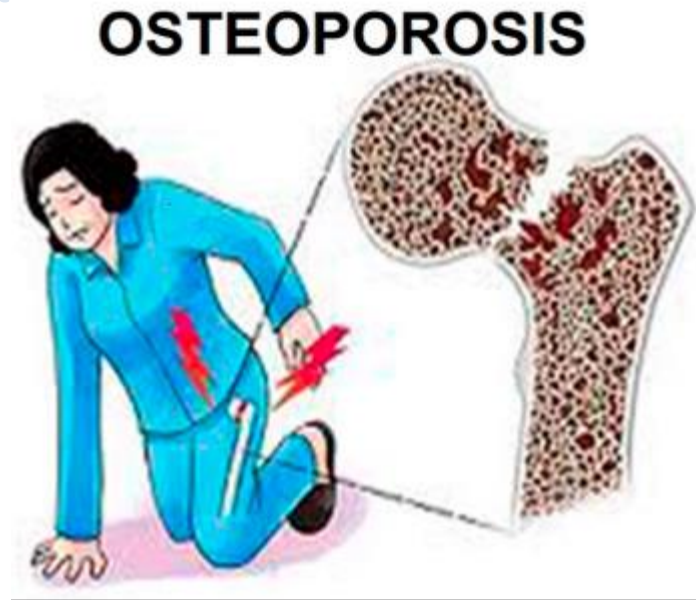
Introduction

- Most common orthopaedic injury with a bimodal distribution
 - younger patients - high energy
 - older patients - low energy / falls
- 50% intra-articular
- Associated injuries
 - DRUJ injuries must be evaluated
 - radial styloid fx - indication of higher energy
 - soft tissue injuries in 70%
 - TFCC injury 40%
 - scapholunate ligament injury 30%
 - lunotriquetral ligament injury 15%



Introduction

- Most common orthopaedic injury with
 - younger patients - high energy
 - older patients - low energy / falls
- 50% intra-articular
- Associated injuries
 - DRUJ injuries must be evaluated
 - radial styloid fx - indication of higher
 - soft tissue injuries in 70%
 - TFCC injury 40%
 - scapholunate ligament injury 30%
 - lunotriquetral ligament injury 15%
- Osteoporosis
 - high incidence of distal radius fractures in women >50
 - distal radius fractures are a predictor of subsequent fractures
 - DEXA scan is recommended in woman with a DRF



DON'T FALL LIKE THIS



Colles' Fractures

- Low energy, DORSALLY displaced, extra-articular fx



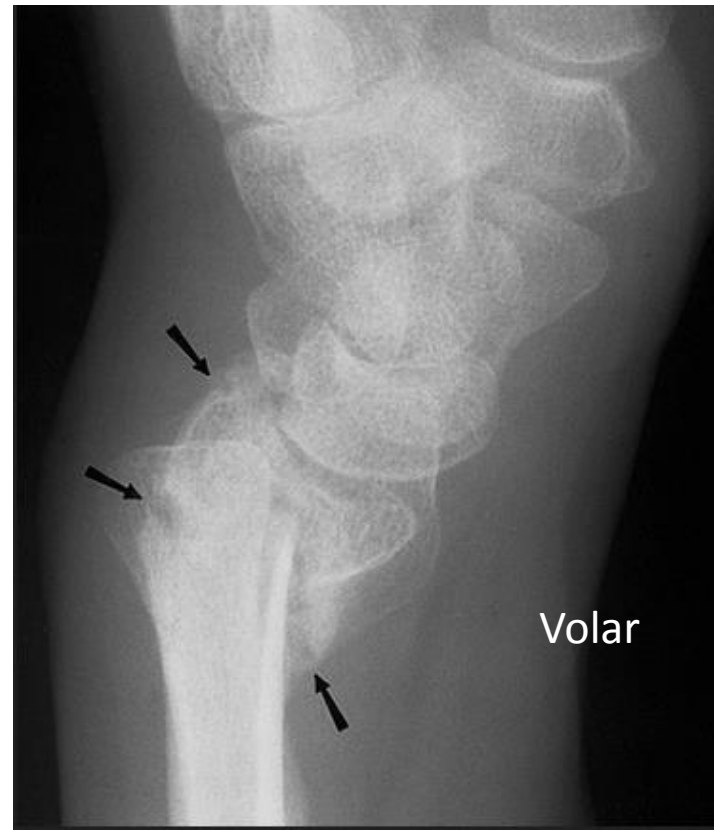
Abraham Colles (1773-1843)
Royal College of Physicians of Ireland

Smith's fx

- Smith's fx Low energy, VOLAR displaced, extra-articular fx



Robert William Smith (1807 – 1873)
Royal College of Surgeons of
Ireland



Barton's fx

- Fx dislocation of radiocarpal joint with intra-articular fx involving the volar or dorsal lip (volar Barton or dorsal Barton fx)

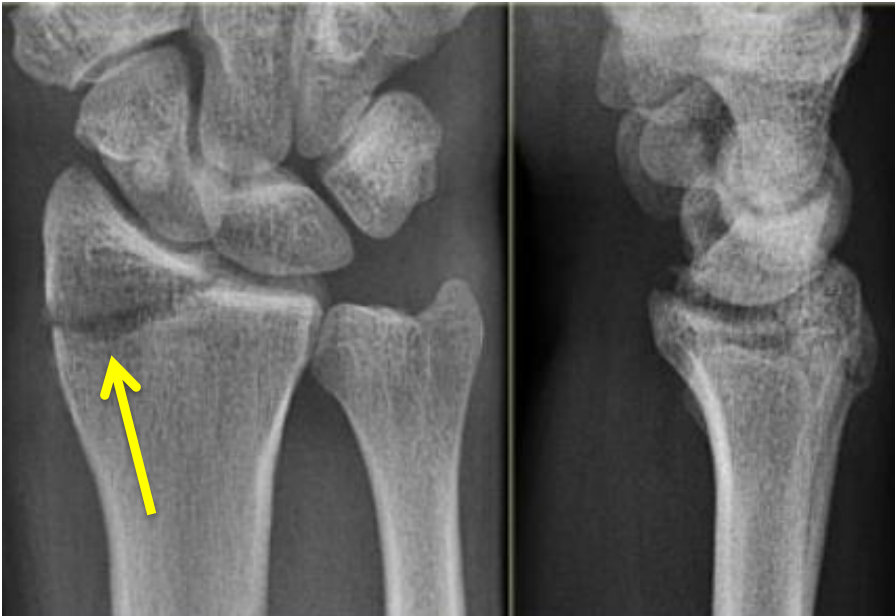


JOHN RHEA BARTON (1794–1871)
Lancaster 1794—Philadelphia 1871



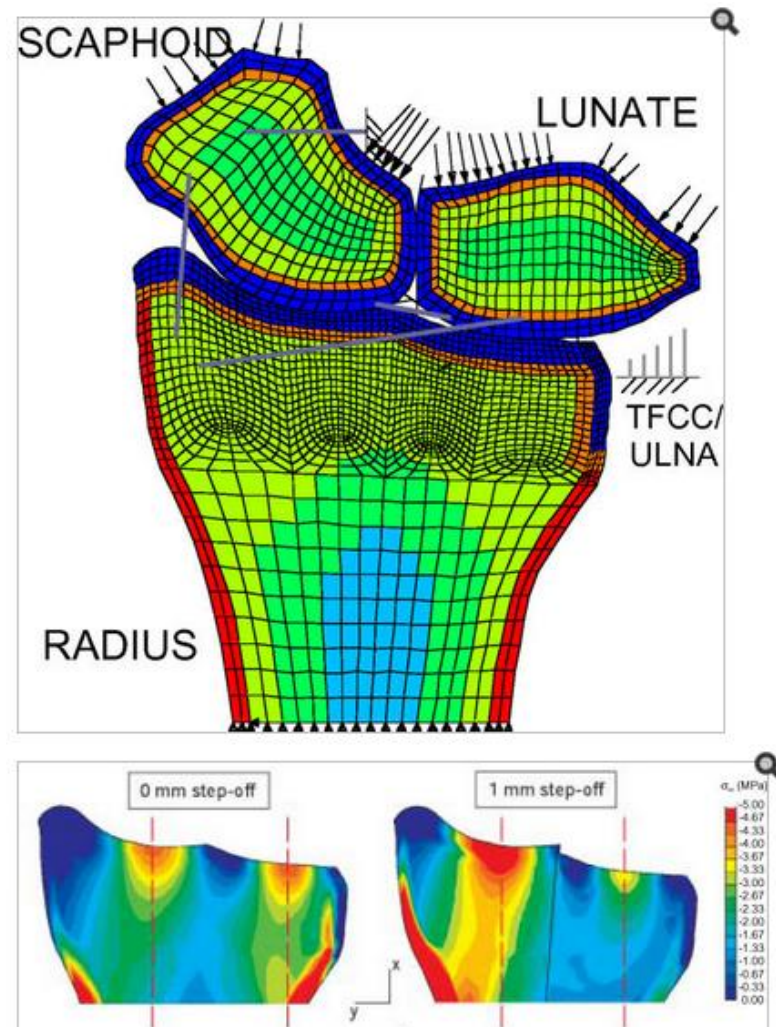
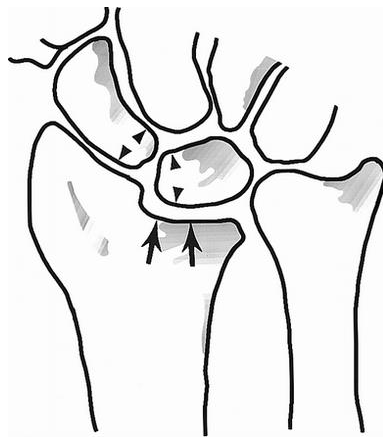
Chauffer's Fracture

- Radial styloid fx



“Die-Punch Fractures”

- A depressed fracture of the lunate fossa of the articular surface of the distal radius



Nondisplaced, Stable Fractures

May be treated
with a pre-fab
splint



Imaging

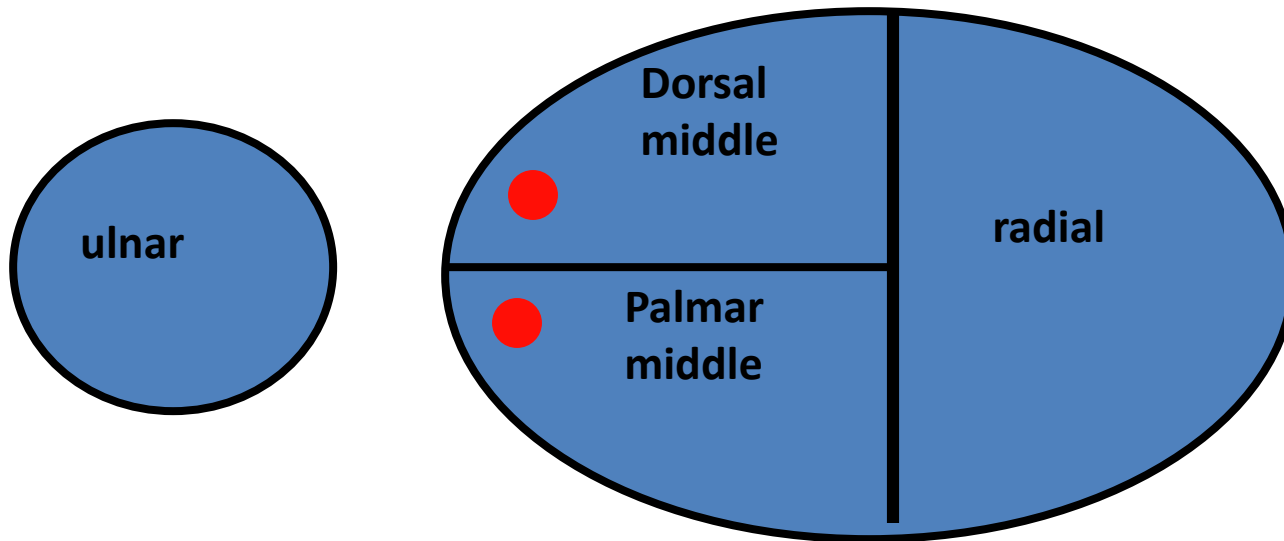
- CT scans
 - important to evaluate intra-articular involvement and for surgical planning
- MRI useful to evaluate for soft tissue injury
 - TFCC injuries
 - scapholunate ligament injuries (DISI)
 - lunotriquetral injuries (VISI)

CT Evaluation of the Distal Radius

- Useful for evaluating intraarticular fx's
- Can be performed in the axial, coronal &/or sagittal planes
- May impact on treatment given

Columnar Classification of the Distal Radius

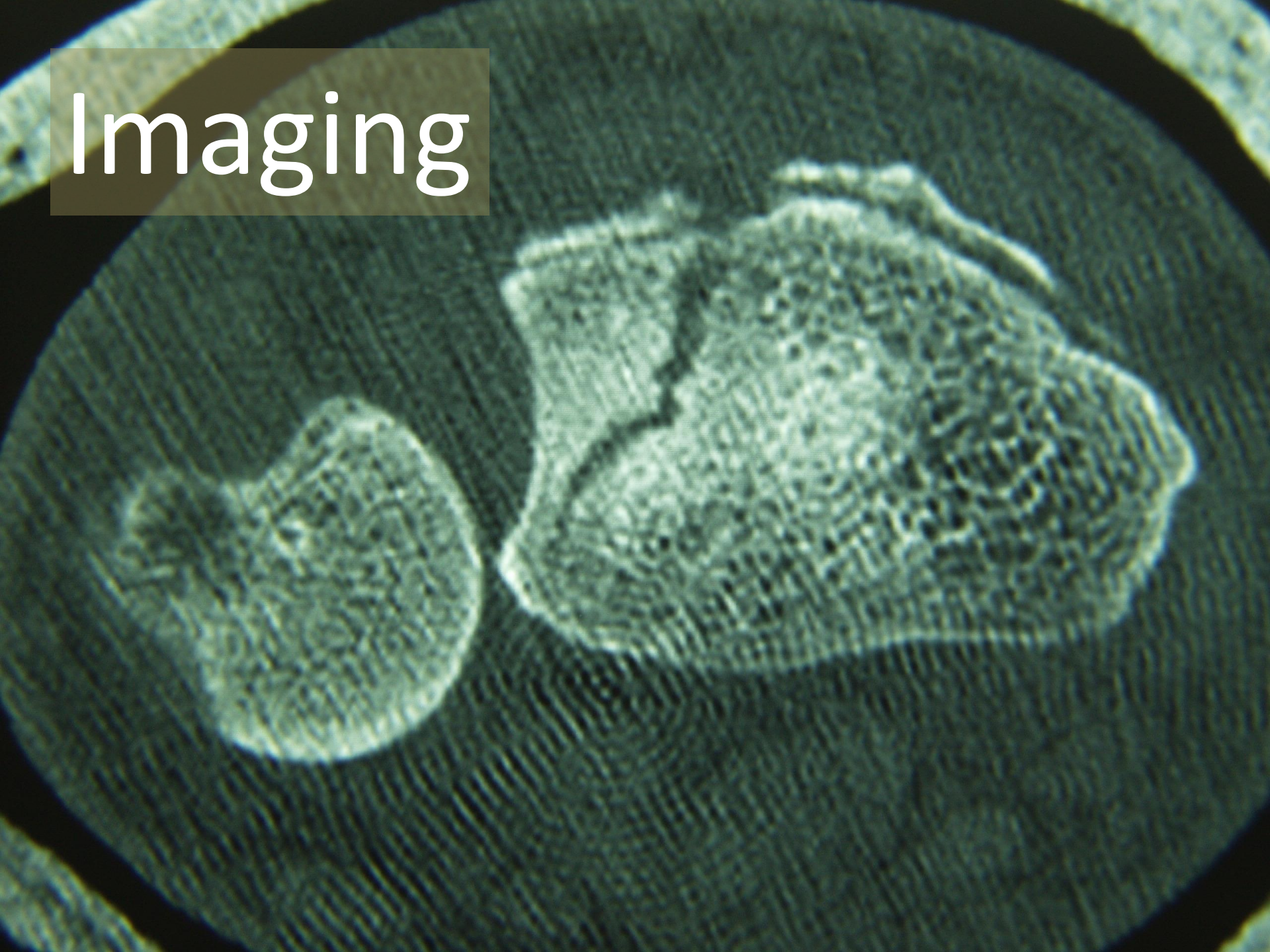
- The distal radius & ulna is divided into three columns--

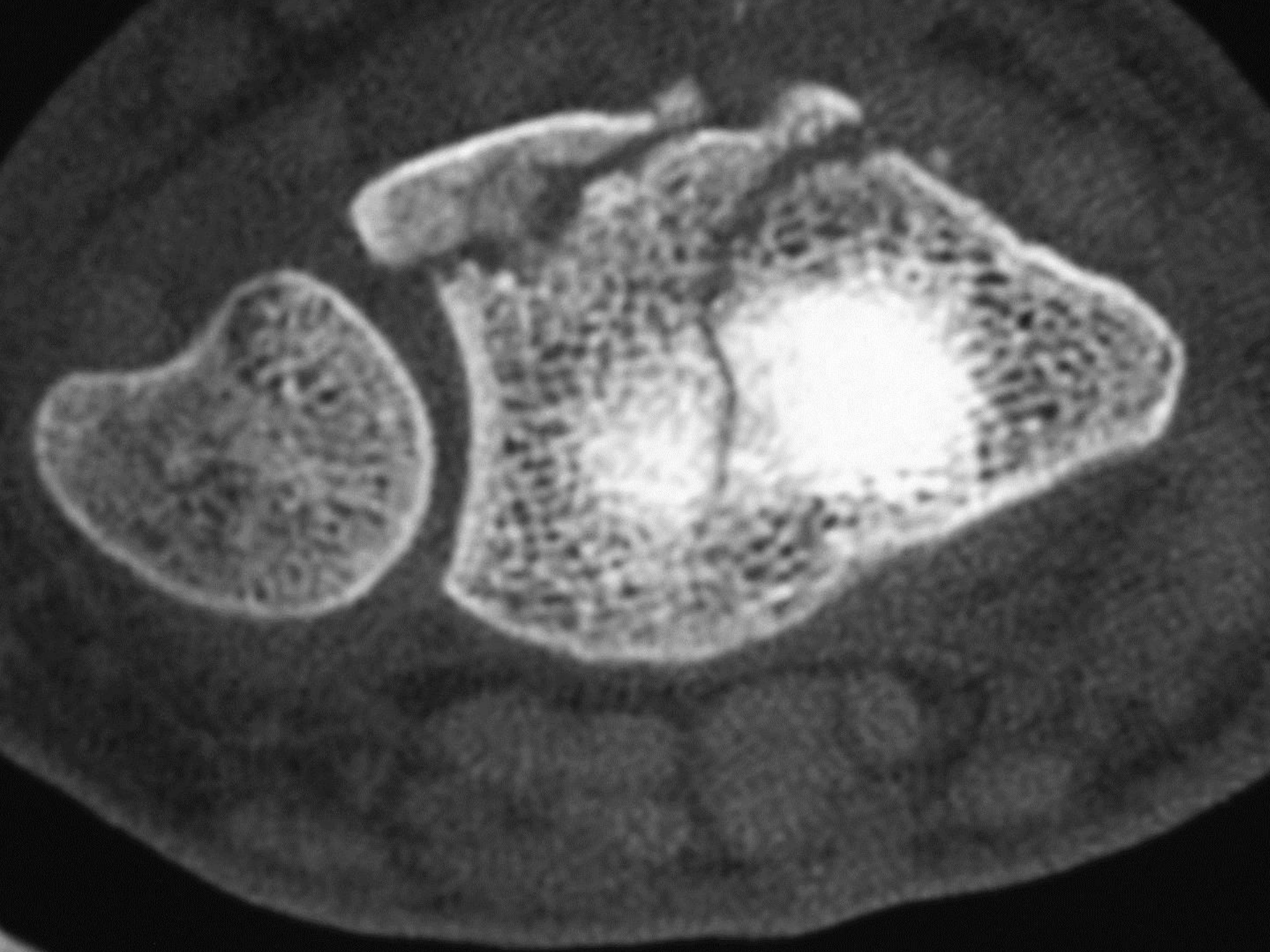


Melone, 1984

● = Difficult to evaluate with plain films

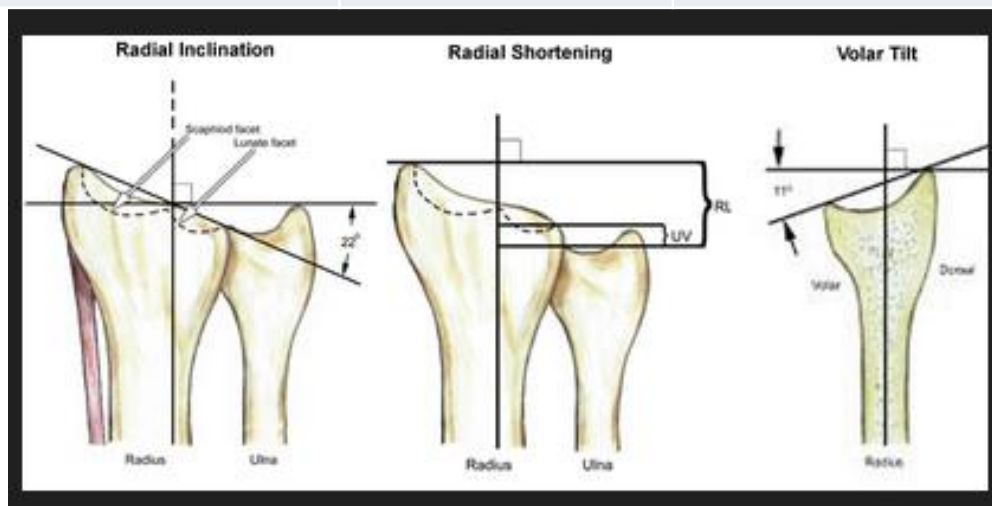
Imaging





Radiographs – Acceptable Criteria

View	Measurement	Normal	Acceptable Criteria
AP	Radial height	11 mm	< 5 mm shortening
	Radial inclination	22 deg	Change < 5 deg's
	Articular stepoff	Congruent	< 2 mm stepoff
Lateral	Volar Tilt	11 deg's	Dorsal angulation < 5 deg's or within 20 deg's of contralateral side



Cast Treatment in Adults

Cast treatment in adults causes undue edema which leads to stiffness and difficult rehabilitation



Non-displaced, Stable Fractures

Children (skeletally immature) may be treated with casts

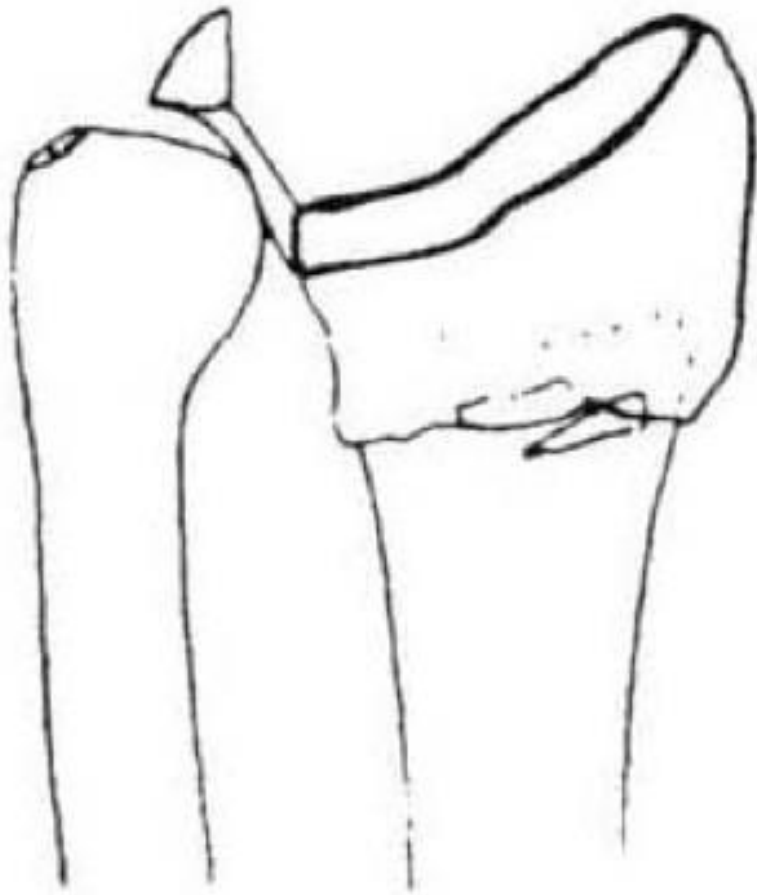


Classification & Treatment

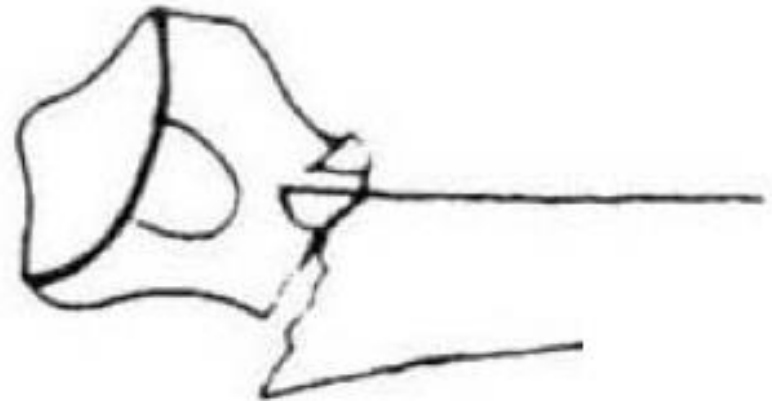
Classification

- Fernandez: based on mechanism of injury
- Frykman: based on joint involvement (radiocarpal and/or radioulnar) +/- ulnar styloid fx
- Melone: divides intra-articular fxs into 4 types based on displacement
- AO: comprehensive but cumbersome

Jupiter & Fernandez Classification

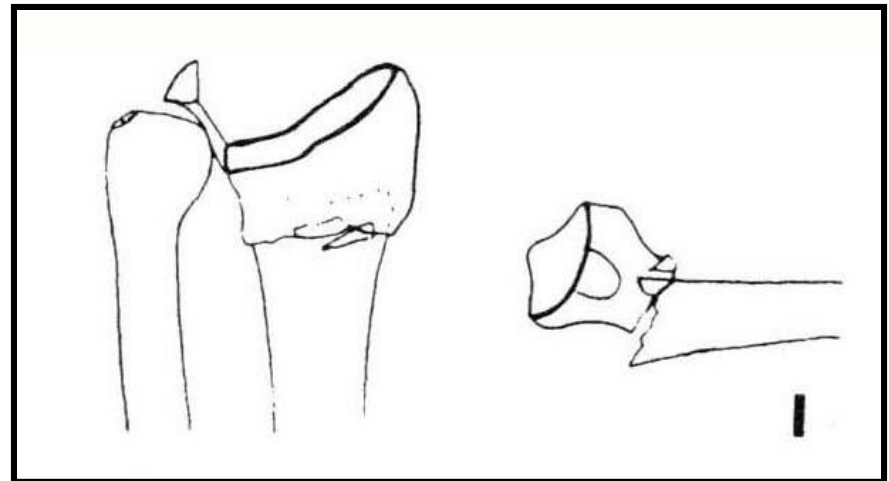


“Bending Fracture”
Type I

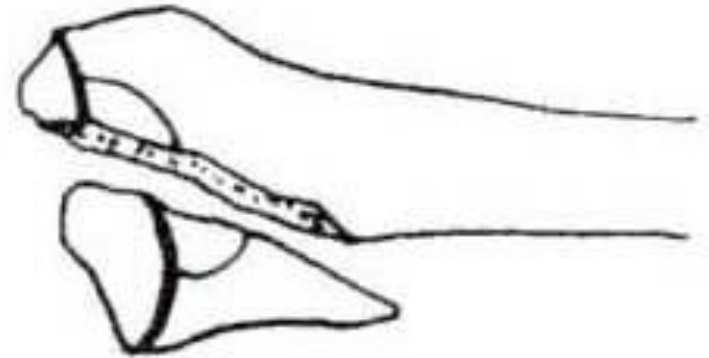
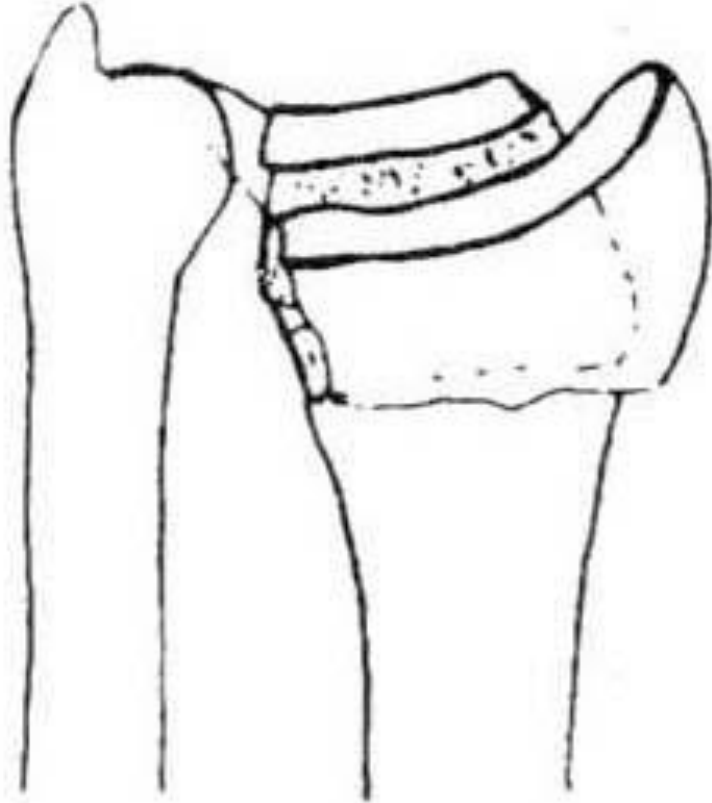


Rx for Type I Fractures

- Nonoperative (Stable fractures)
- Percutaneous pinning (extra- or intrafocal)
- External fixation
- Exceptionally;
Bone graft



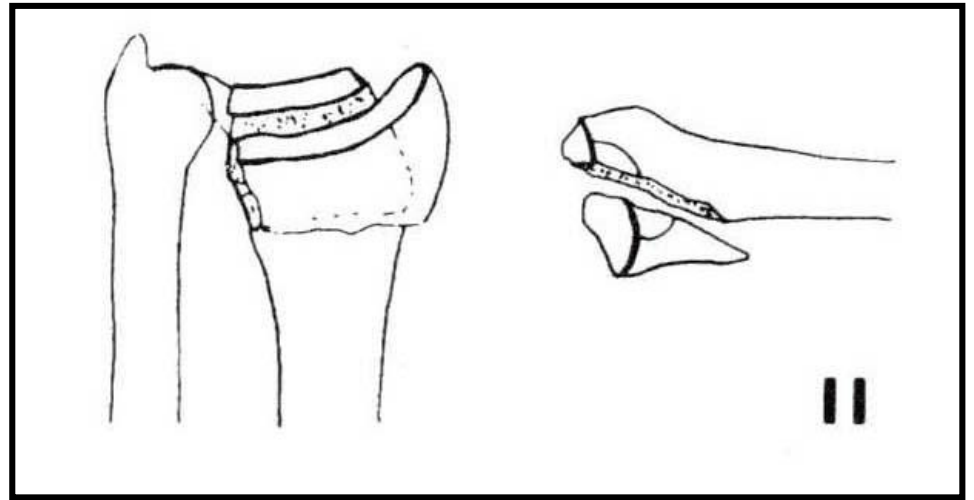
Jupiter & Fernandez Classification



“Shearing Fracture”
Type II

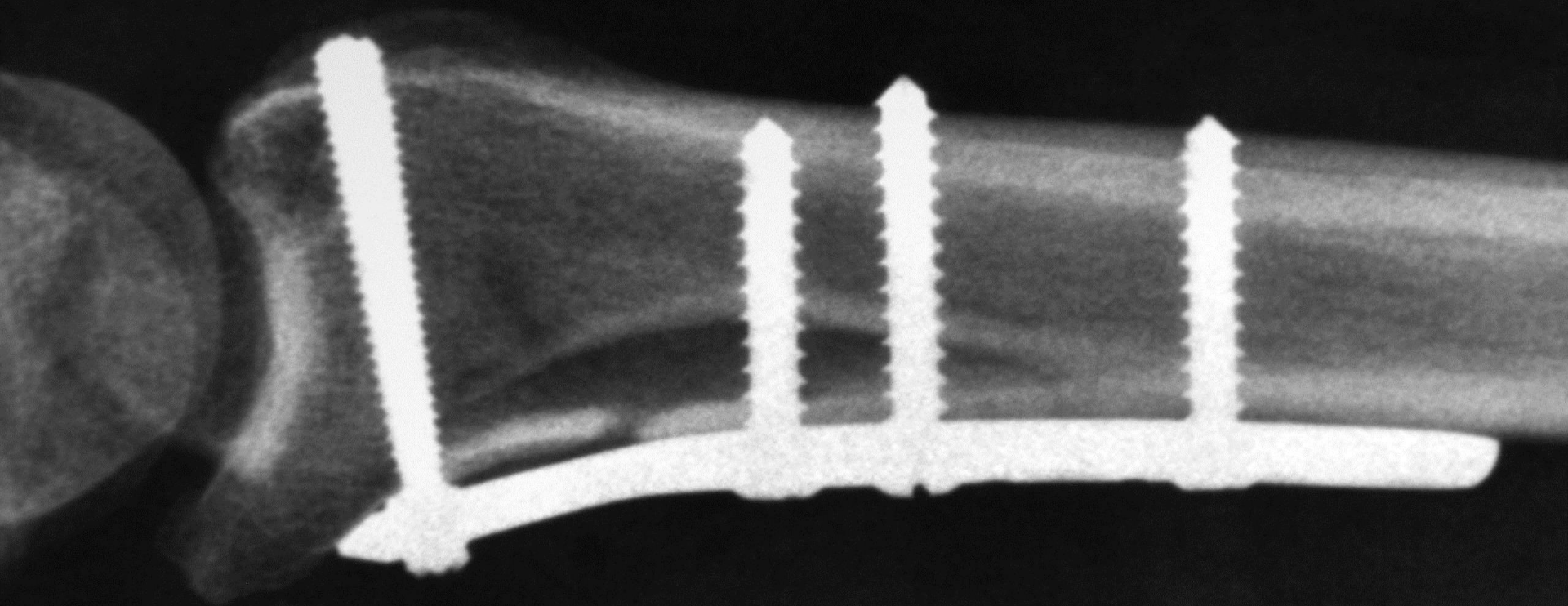
Jupiter & Fernandez Classification

- Open reduction &
Screws & plate fixation
("Buttress Plate")



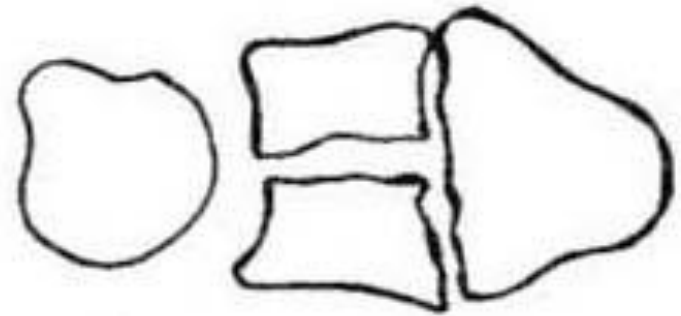
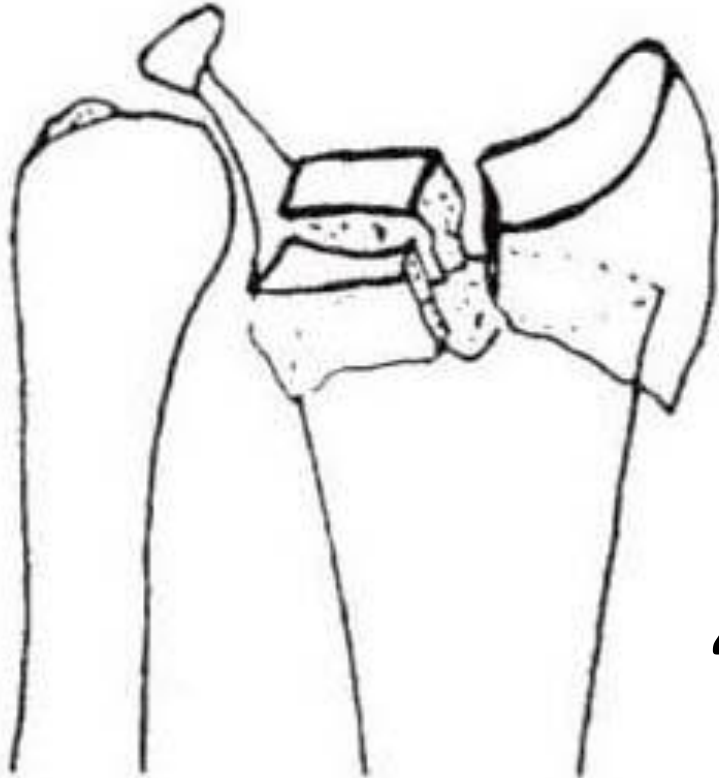
Type II





Type II-Rx

Jupiter & Fernandez Classification



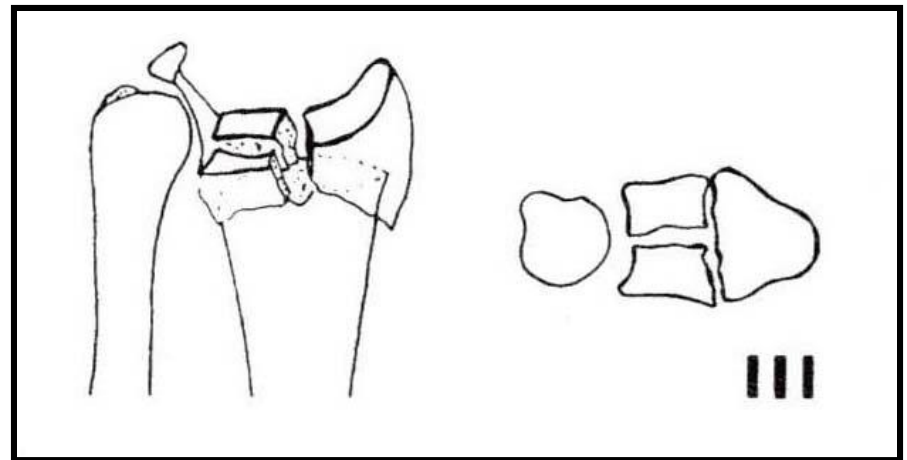
“Compression Fracture”

Type III

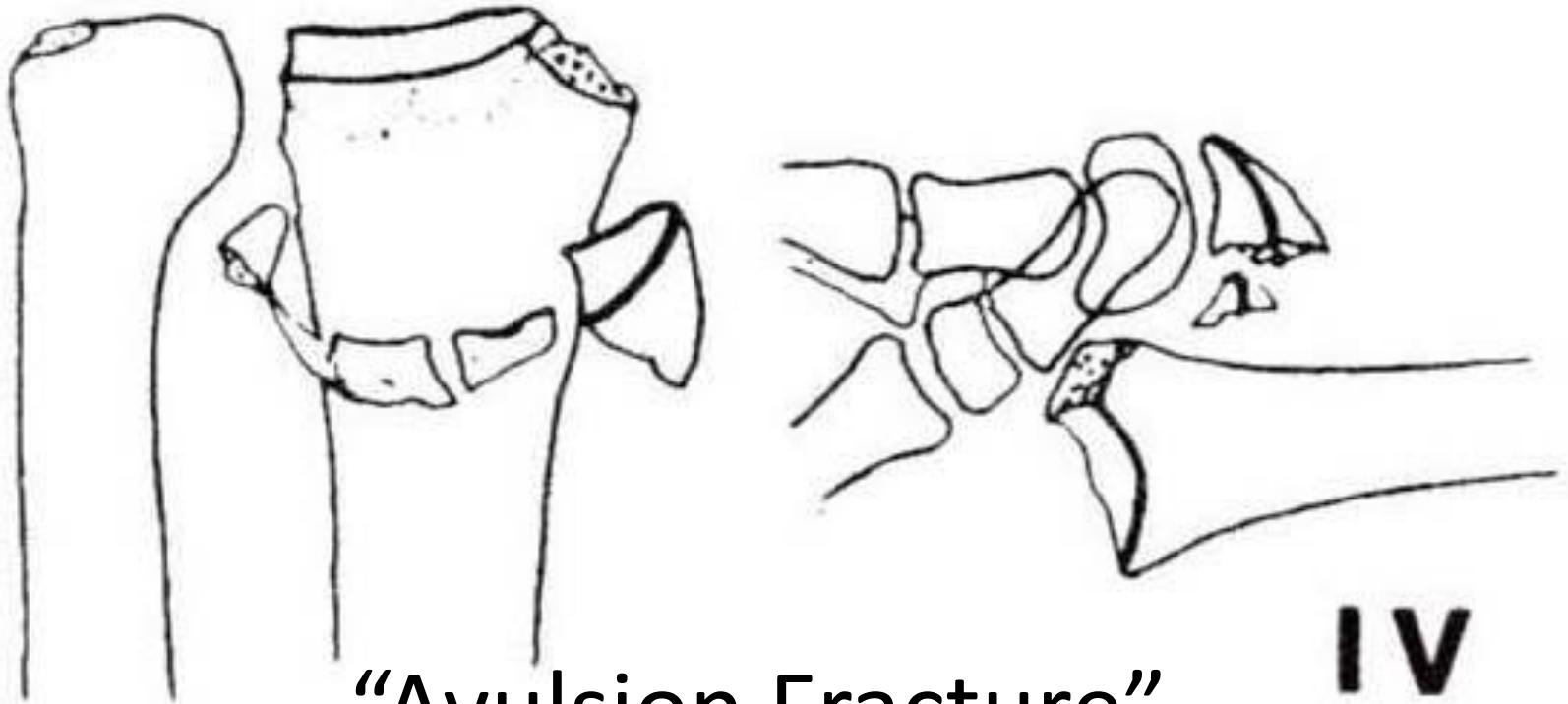


Jupiter & Fernandez Classification

- Nonoperative (Closed)
- Limited open
- Arthro assist
- Extensile (open)
- Percutaneous
 - pinning +/- external &/or internal fixation
- Bone graft



Jupiter & Fernandez Classification

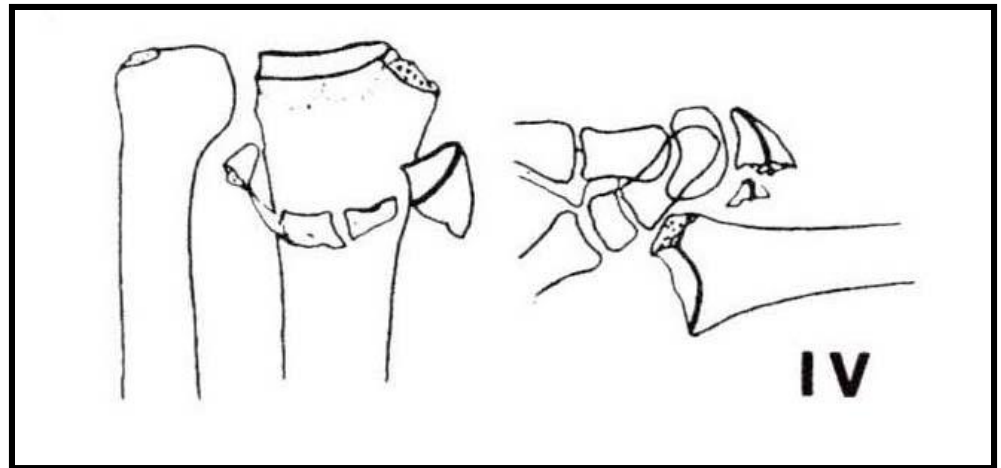


“Avulsion Fracture”

Type IV

Jupiter & Fernandez Classification

- Closed or open reduction
- Pin or screw fixation
- Tension wiring



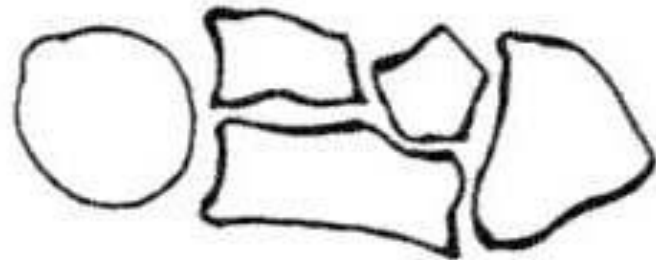
Jupiter & Fernandez Classification



“Type V (A & B)

A = “Combined Fracture”

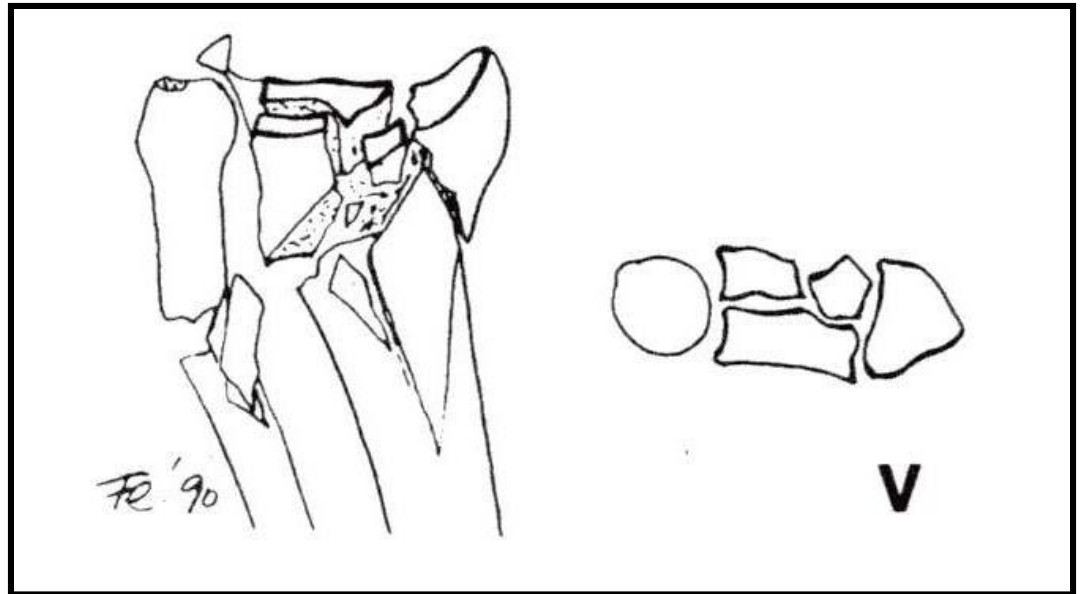
B = “Complex Fracture”



Complex = Extension
into the shaft

Jupiter & Fernandez Classification

- Combined method



Treatment

- Successful outcomes correlate with:
 - Accuracy of the articular reduction
 - Restoration of anatomic relationship
 - Early return of ROM (wrist, forearm and fingers)

Treatment (con't)

- Non-operative (closed reduction & cast)
 - Indications
 - Extra-articular
 - <5mm radial shortening
 - Dorsal angulation <5 deg or within 20 deg of contralateral side

Treatment (con't)

- Operative (CRPP, External Fixation, ORIF)
 - Indications: x-ray findings indicating instability (pre-reduction x-rays are best predictor of stability)
 - Displaced intra-articular fx's
 - Volar or dorsal comminution
 - Articular margin fx's
 - Severe osteoporosis
 - Dorsal angulation > 5 deg or > 20 deg of contralateral side
 - (con't)

Treatment (con't)

- Operative (con't)
- > 5 mm radial shortening
- Comminuted & displaced extra-articular fx's (e.g., Smith)
- Progressive loss of volar tilt & loss of radial length following closed reduction & casting
- Assoc ulnar styloid fx's usually do not require fixation

Closed Reduction & Cast Treatment

- Indications
 - Most extra-articular fx's
- Technique
 - Rehabilitation
 - Early ROM is can be beneficial to prevent finger stiffness, edma & CRPS
- Outcomes
 - Repeat closed reduction have <50% satfactory results
- Complications
 - EPL rupture

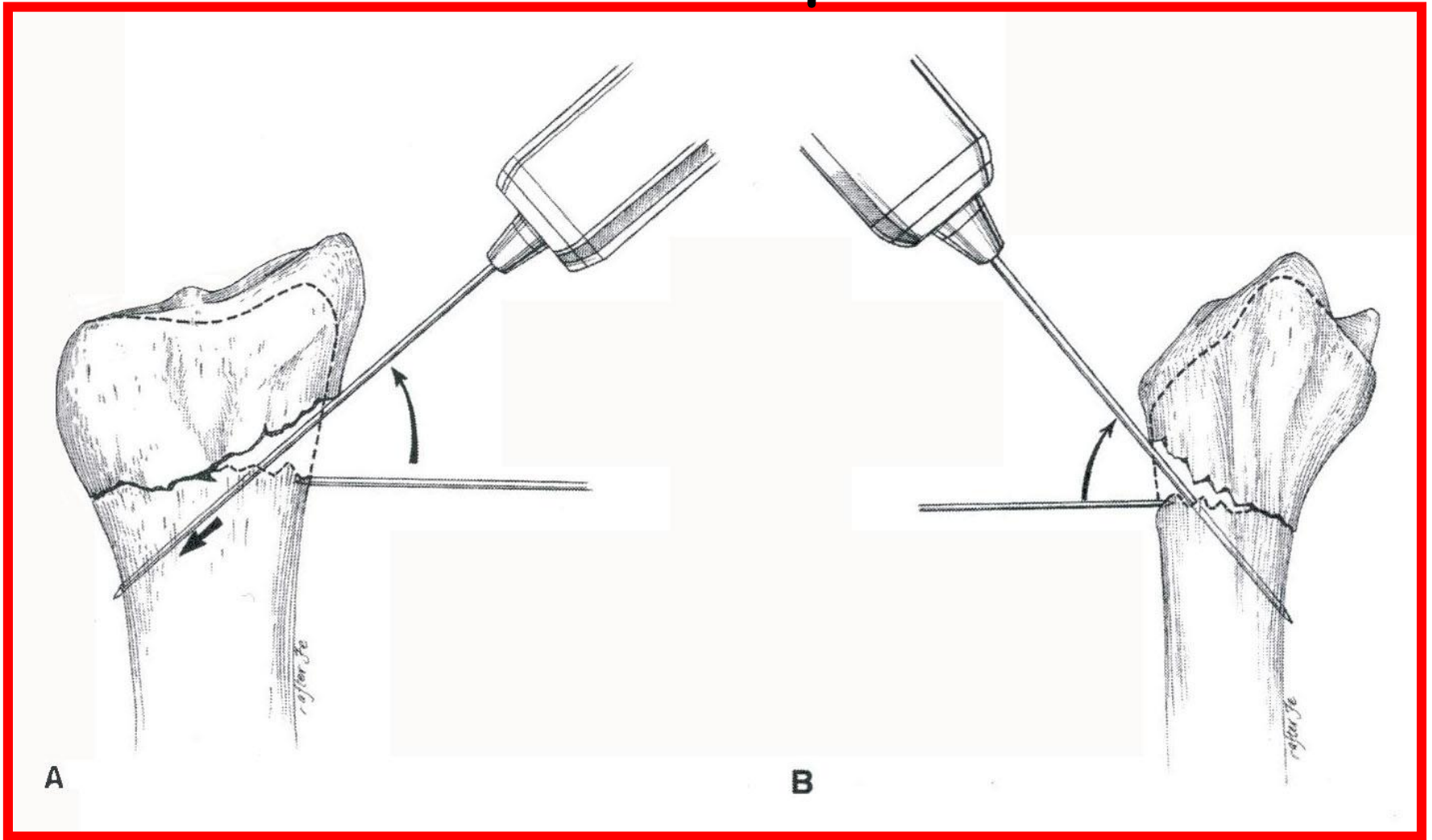
Percutaneous Pinning

- Indications
 - Can maintain sagittal length/alignment in extra-articular fx's with stable volar cortex
 - Cannot maintain length/alignment when unstable or comminuted volar cortex
- Techniques
 - Kapandji intrafocal technique
 - Other e.g., Rayhack, arthroscopically assisted, etc.
- Outcomes
 - 82-90% good results (if used appropriately)





Intrafocal Pinning Kanpandji Technique



Hook Plate



External Fixation

- Indication
 - Alone cannot reliably restore 10 deg's palmar tilt
 - usually combined with percutaneous pinning technique or plate fixation
- Technical considerations
 - relies on ligamentotaxis to maintain reduction
 - place radial shaft pins under direct visualization to avoid injury to superficial radial nerve
 - nonspanning ex-fix can be useful if large articular fragment
 - avoid overdistraction (carpal distraction < 5mm in neutral position) and excessive volar flexion and ulnar deviation
 - limit duration to 8 weeks and perform aggressive OT to maintain digital ROM
- Outcomes
 - important adjunct with 80-90% good/excellent results
 - Popularity has gone down
- Complications
 - malunion/nonunion
 - stiffness and decreased grip strength
 - pin complications (infections, fx through pin site, skin difficulties)
 - pin site care comprising daily showers and dry dressings recommended
 - neurologic (iatrogenic injury to radial sensory nerve, median neuropathy, RSD)

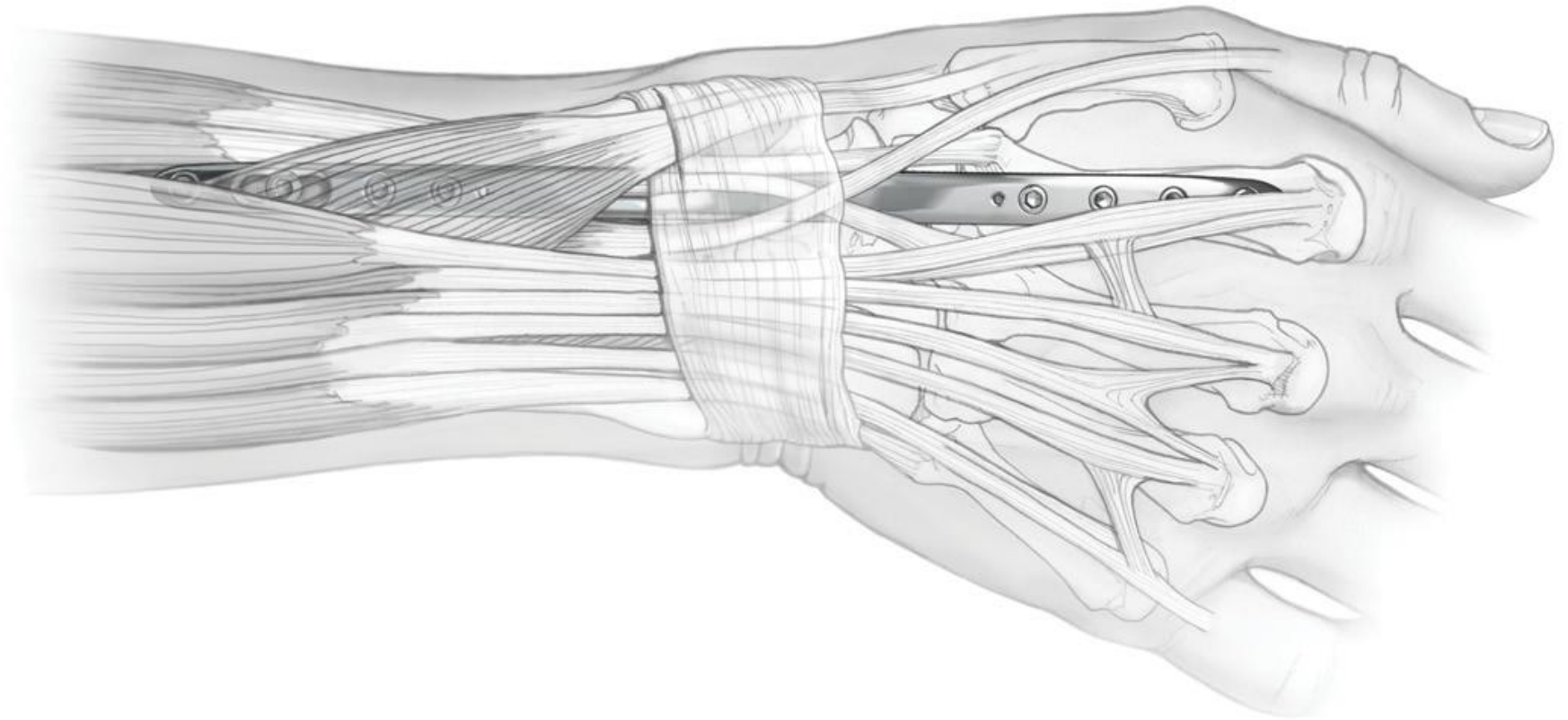
External Fixation



Bridge Plating

- Indication
 - Similar to external fixation
 - Alone CAN reliably restore 10 deg's palmar tilt
 - Can be combined with percutaneous pinning technique or plate fixation
 - Similar to external fixation
- Technical considerations
 - Relies on ligamentotaxis to maintain reduction
 - Place radial shaft pins under direct visualization to avoid injury to superficial radial nerve or ext tendons
 - Avoid over-distraction (carpal distraction < 5mm in neutral position) and excessive volar flexion and ulnar deviation
 - Limit duration to 8 weeks in young healthy bone and perform aggressive OT to maintain digital ROM
 - Duration 3mos, 6mos, or indefinite depending on the quality of the bone
- Outcomes
 - 80-90% good/excellent results
 - Popularity has increased
- Complications
 - Malunion/nonunion
 - Stiffness and decreased grip strength
 - Pin complications (infections, fx through pin site, skin difficulties)
 - Pin site care comprising daily showers and dry dressings recommended
 - Neurologic (iatrogenic injury to radial sensory nerve, median neuropathy, RSD)

Bridge Plating





ORIF

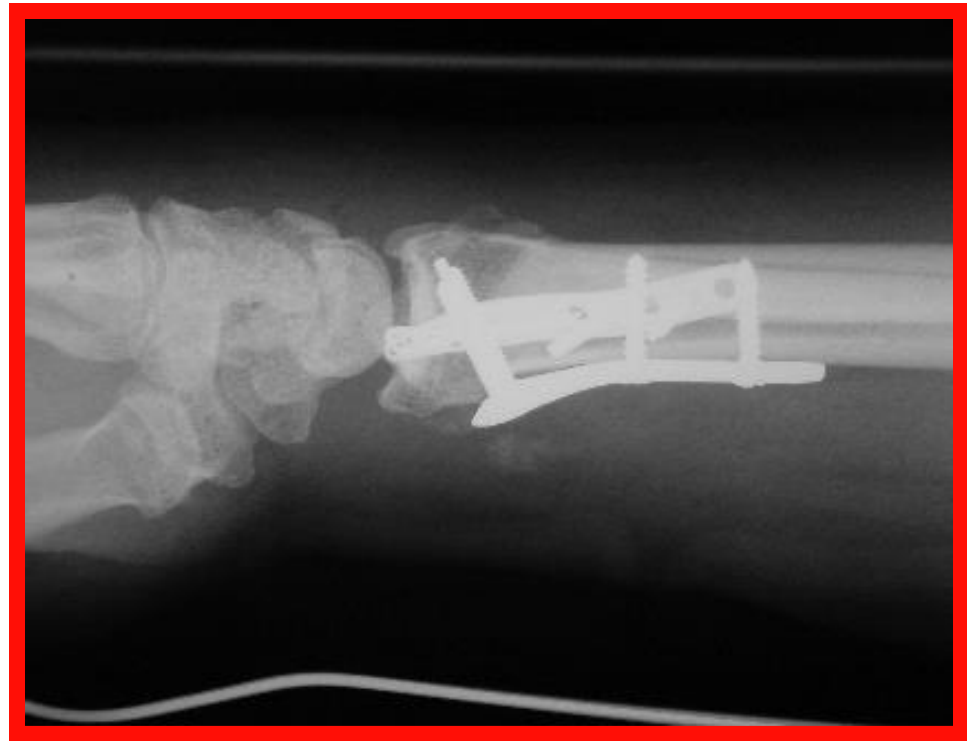
- Indications
 - Significant articular displacement (>2mm)
 - Dorsal and volar Barton fxs
 - Volar comminution
 - Metaphyseal-diaphyseal extension
 - Associated distal ulnar shaft fxs
 - Die-punch fxs
- Technique
 - Volar plating
 - volar plating preferred over dorsal plating
 - volar plating associated with irritation of both flexor and extensor tendons
 - rupture of FPL is most common with volar plates
 - associated with plate placement distal to watershed area, the most volar margin of the radius closest to the flexor tendons
 - new volar locking plates offer improved support to subchondral bone
 - Dorsal plating
 - dorsal plating historically associated with extensor tendon irritation and rupture
 - dorsal approach indicated for displaced intra-articular distal radius fracture with dorsal comminution
 - other technical considerations
 - can combine with external fixation and PCP
 - bone grafting if complex and comminuted
 - study showed improved results with arthroscopically assisted reduction
 - volar lunate facet fragments may require fragment specific fixation to prevent early post-operative failure

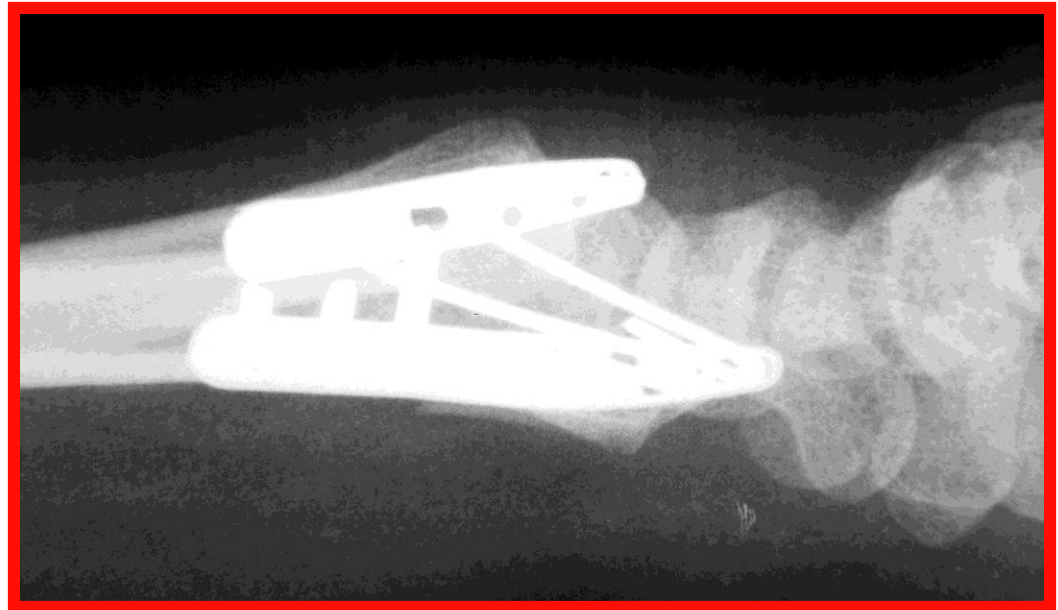
10 months post-op bearing plate





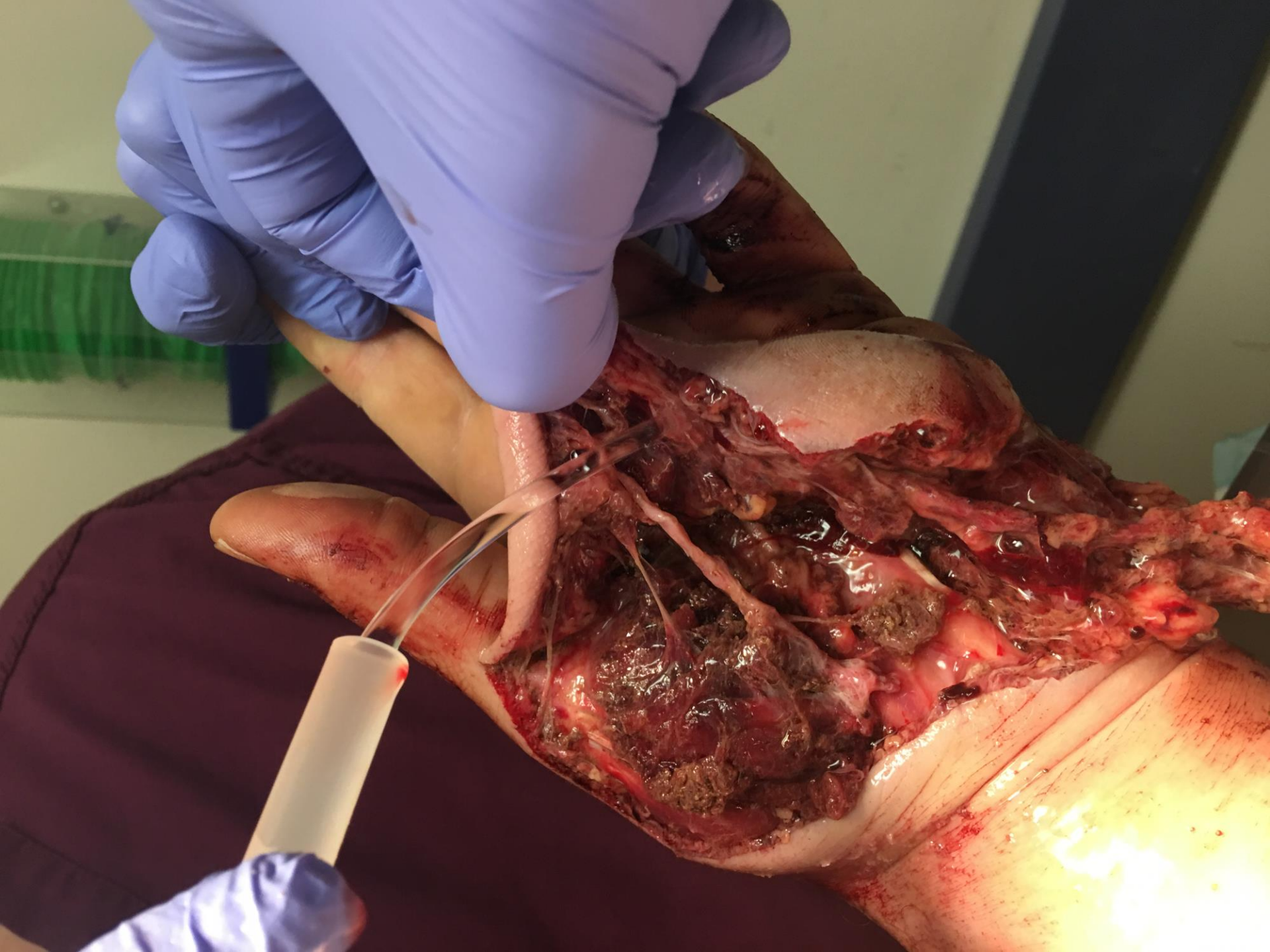
“90-90 Construct”



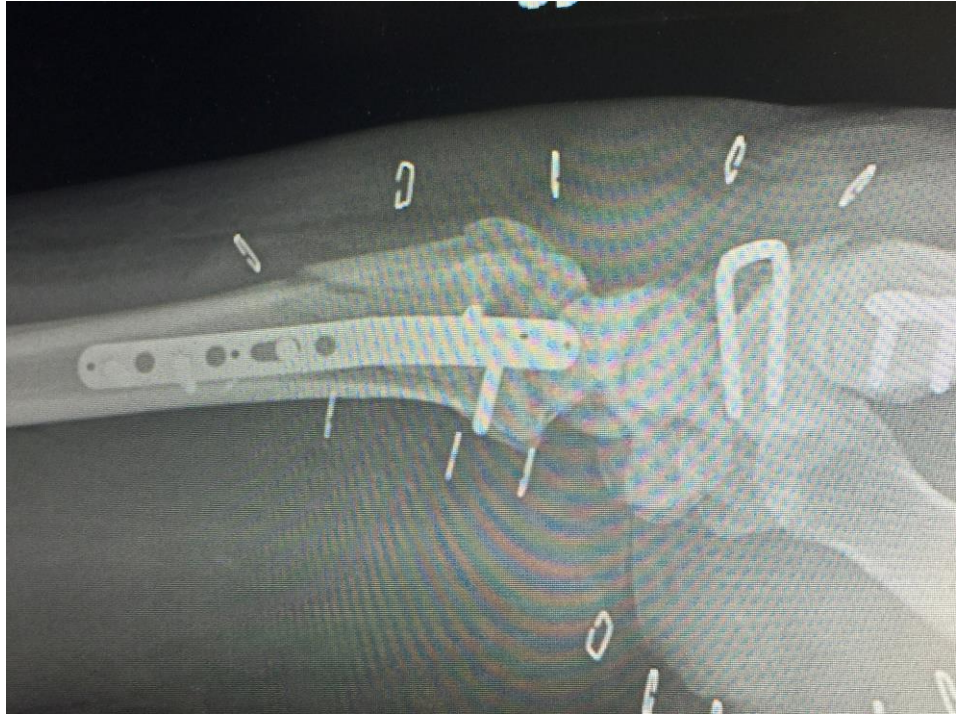


Case:

44-year-old chef sustained an injury to his left (non-dominant) wrist as a result of a ATV mishap. The patient was transferred to UMC for definitive treatment.











Reported Complications with Distal Radius Fractures

Complication	Incidence
Loss of motion (marked deformity, decreased ROM, arthrofibrosis, Volkmann's ischemic contracture, finger stiffness)	0%–31%
Nerve compression/neuritis	0%–17%
Delayed union/nonunion	0.7%–4%
Pain syndromes (RSD, shoulder-hand syndrome, persistent pain)	0.3%–8%
Hardware complications	1.4%–2.6%
Osteomyelitis	4%–9%
Malunion	5%

McKay SD, MacDermid JC, Roth JH, et al. Assessment of complications of distal radius fractures and development of a complication checklist. *J Hand Surg Am* 2001;26(5):916–22.

Reported Complications with Distal Radius Fractures (con't)

Complication	Incidence
Tendon (rupture, lag, trigger, tenosynovitis)	0%–5%
Scar (keloids)	3%
Ligament damage	98%
Radioulnar (synostosis, disturbance)	0%–1.3%
Bone graft hematoma	1%
Dupuytren's contracture (palmar fascia nodules/bands)	2%–9%
Arthritis/arthrosis	7%–65%
Unrecognized injury	2%

McKay SD, MacDermid JC, Roth JH, et al. Assessment of complications of distal radius fractures and development of a complication checklist. J Hand Surg Am 2001;26(5):916–22.

Complications

Injury. 2017 Jun;48(6):1104-1109. doi: 10.1016/j.injury.2017.03.008. Epub 2017 Mar 10.

Complications of volar locking plating of distal radius fractures in 576 patients with 3.2 years follow-up.

Thorninger R¹, Madsen ML², Wæver D³, Borris LC⁴, Rölfing JHD⁴.

⊕ Author information

Abstract

BACKGROUND: Volar plating of unstable distal radius fractures (DRF) has become the favoured treatment. The complication rates vary from 3 to 36%. The purpose of the study was to estimate the complication rate of volar plating of DRF and its association with AO/OTA fracture type, surgeon experience and type of volar plate.

METHODS: Retrospectively, all patients treated with volar plating of a DRF between February 2009 and June 2013 at Aarhus University Hospital, Denmark were included. AO/OTA fracture type, surgeon experience (1st year, 2nd-5th year resident or consultant), type of plate (VariAx[®], Acu-Loc[®]) and complications were extracted from the electronic medical records. Complications were categorized as carpal tunnel syndrome, other sensibility issues, tendon complications including irritation and rupture, deep infections, complex regional pain syndrome and unidentified DRUJ or scapholunar problems. Reoperations including hardware removal were also charted.

RESULTS: 576 patients with a median age of 63 years (min: 15; max: 87) were included. 78% were female and the mean observation time was 3.2 years (min: 2.0; max: 5.4). 78% (n=451) of the patients were treated with VariAx[®] and 22% (n=125) with Acu-Loc[®]. The overall complication rate was 14.6% (95% CI 11.8-17.7) including carpal tunnel syndrome or change in sensibility in 5.2% and tendon complications in 4.7%. Five flexor tendon ruptures and 12 extensor tendon ruptures were observed. The reoperation rate was 10.4% including 41 cases of hardware removal. A statistically significant association between AO/OTA fracture type C and complications was found. No statistically significant association between complication rate and surgeon experience and type of plate was observed.

CONCLUSION: The majority of DRF patients treated with a volar plate suffer no complications. However, the overall complication rate of 14.6% is substantial. Intra-articular fractures, e.g. AO/OTA-type 23C1-3, had significantly higher complication rates. Neither surgeon experience, nor type of volar plate was able to predict complications.

Complications

Plast Reconstr Surg. 2017 Mar;139(3):717e-724e. doi: 10.1097/PRS.0000000000003076.

Tendon Rupture and Tenosynovitis following Internal Fixation of Distal Radius Fractures: A Systematic Review.

Azzi AJ¹, Aldekhayel S, Boehm KS, Zadeh T.

⊕ Author information

Abstract

BACKGROUND: Tendon-related complications after plate fixation of distal radius fractures can cause significant morbidity in the patient. This retrospective systematic review aims to report and compare the current rate of tendon rupture and tenosynovitis complicating the operative management of distal radius fractures.

METHODS: A systematic literature search was performed to identify relevant articles reporting tendon complications after operative management of distal radius fractures. The search included published articles in three electronic databases-Ovid MEDLINE, EMBASE, and the Cochrane Library-starting from the establishment of each database to February of 2016.

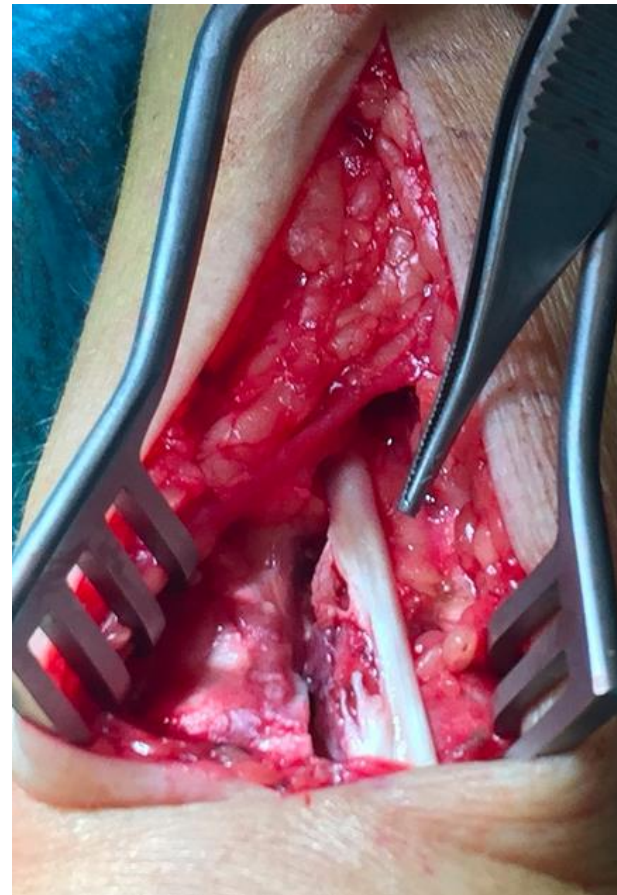
RESULTS: A total of 56 studies met the inclusion criteria, including 6278 patients. Overall tendon-related adverse events were reported in 420 patients (6.8 percent). The incidence of tendon rupture was 1.5 percent with volar plates and 1.7 percent with dorsal plates. The incidence of tenosynovitis was 4.5 percent with volar plates and 7.5 percent with dorsal plates. Individual tendon complications were reported with volar and dorsal fixation, respectively: extensor pollicis longus tenosynovitis (0.3 percent and 1.1 percent), extensor pollicis longus rupture (0.8 percent and 0.3 percent), flexor pollicis longus tenosynovitis (1.3 percent and 0 percent), flexor pollicis longus rupture (0.6 percent and 0.2 percent), flexor digitorum profundus/flexor digitorum superficialis tenosynovitis (1.2 percent and 1.3 percent), flexor digitorum profundus/flexor digitorum superficialis rupture (0.1 percent and 0 percent), extensor digitorum communis tenosynovitis (1.7 percent and 5.9 percent), and extensor digitorum communis rupture (0.05 percent and 1.3 percent).

CONCLUSION: This systematic review provides an update on the literature regarding tendon-related complications in the management of distal radius fractures.

Complications

Table 1. Total Complication Rates with Volar and Dorsal Plating in Distal Radius Fractures

	Volar Plates		Dorsal Plates	
	Total	Events (%)	Total	Events (%)
Tenosynovitis	2631	119 (4.5)	496	37 (7.5)
Tendon rupture	5222	78 (1.5)	1032	18 (1.7)



Azzi, et al: Tendon rupture and tenosynovitis following internal fixation of distal radius fractures: A systematic review. PRS 2017 Mar 139(3):717-24.

Complications

Table 4. Complications Related to Individual Tendons and Tendon Groups

	Volar		Dorsal	
	Total	Events (%)	Total	Events (%)
EPL tenosynovitis	1538	5 (0.3)	376	4 (1.1)
FPL tenosynovitis	1516	19 (1.3)	376	0 (0)
FDP plus FDS tenosynovitis	1492	18 (1.2)	376	5 (1.3)
EDC tenosynovitis	1892	32 (1.7)	457	27(5.9)
EPL rupture	4638	37 (0.8)	1032	3 (0.3)
FPL rupture	4504	25 (0.6)	891	2 (0.2)
FDP plus FDS rupture	4347	6 (0.1)	891	0 (0)
EDC rupture	4212	2 (0.05)	972	13 (1.3)

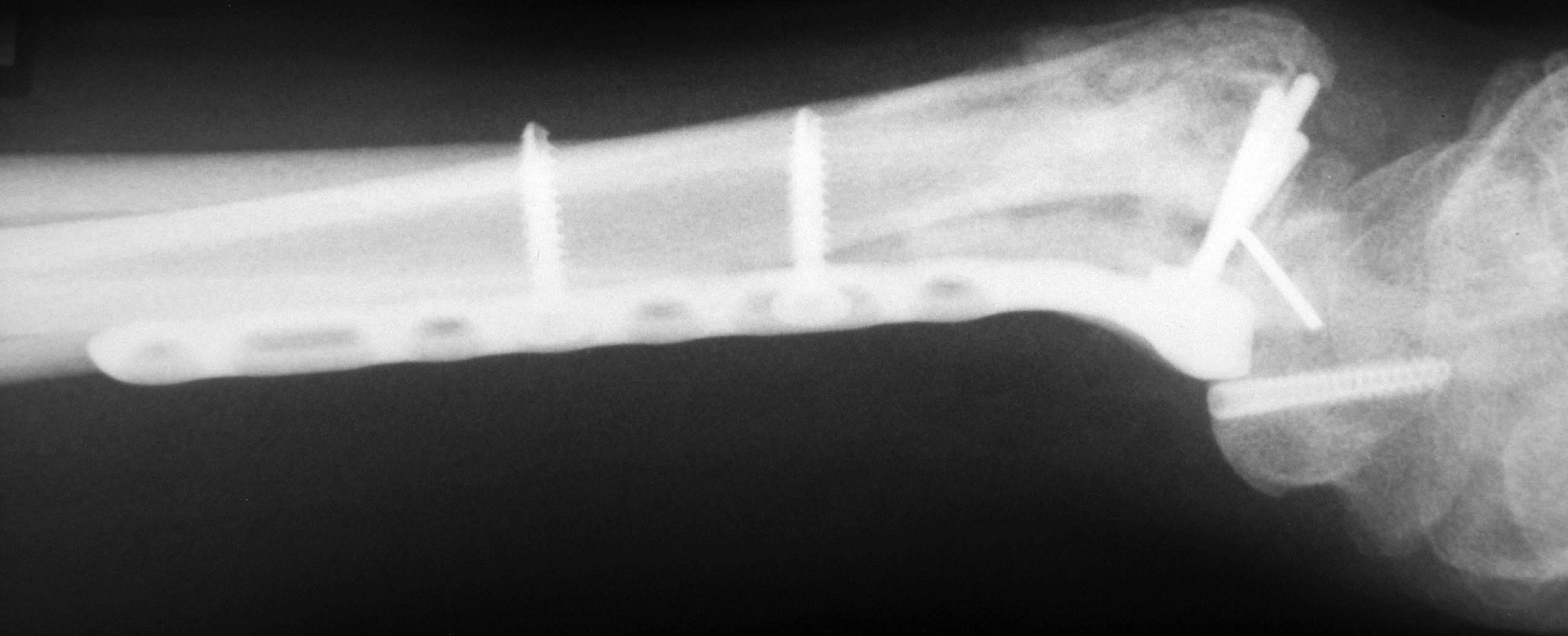
EPL, extensor pollicis longus; FPL, flexor pollicis longus; FDP, flexor digitorum profundus; FDS, flexor digitorum superficialis; EDC, extensor digitorum communis; EPL, extensor pollicis longus.

Hardware Failure



JPEG 4.01:1 Q=90 (lossy)
[H]

Fixation Failure



Midterm Outcome

J Bone Joint Surg Am. 1997 Sep;79(9):1290-302.

Displaced intra-articular fractures of the distal aspect of the radius. Long-term results in young adults after open reduction and internal fixation.

Catalano LW 3rd¹, Cole RJ, Gelberman RH, Evanoff BA, Gilula LA, Borrelli J Jr.

⊕ Author information

Abstract

The purpose of this retrospective study was to determine the long-term functional and radiographic outcomes in a series of young adults (less than forty-five years old) in whom an acute displaced intra-articular fracture of the distal aspect of the radius had been treated with operative reduction and stabilization. Twenty-six fractures in twenty-six patients met the initial inclusion criteria for the study. Twenty-one patients returned for a physical examination, imaging (plain radiographs and computerized tomography scans), and completion of a validated musculoskeletal function assessment questionnaire at a minimum of 5.5 years. The physical examinations were performed by the same observer, who was not involved in the initial care of the patients. The plain radiographs and computerized tomography scans were assessed in a blinded fashion by two independent observers who measured the radiographic parameters with standardized methods. At an average of 7.1 years, osteoarthritis of the radiocarpal joint was evident on the plain radiographs and computerized tomography scans of sixteen (76 per cent) of the twenty-one wrists. A strong association was found between the development of osteoarthritis of the radiocarpal joint and residual displacement of articular fragments at the time of osseous union ($p < 0.01$). However, the functional status at the time of the most recent follow-up, as determined by physical examination and on the basis of the responses on the questionnaire, did not correlate with the magnitude of the residual step and gap displacement at the time of fracture-healing. All patients had a good or excellent functional outcome irrespective of radiographic evidence of osteoarthritis of the radiocarpal or the distal radio-ulnar joint or non-union of the ulnar styloid process. It appears prudent therefore to base the indications for salvage operative procedures on the presence of severe symptoms or a loss of function rather than on radiographic evidence of osteoarthritis of the radiocarpal joint.

Long Term Outcome

J Hand Surg Am. 2006 Apr;31(4):633-9.

Fifteen-year outcome of displaced intra-articular fractures of the distal radius.

Goldfarb CA¹, Rudzki JR, Catalano LW, Hughes M, Borrelli J Jr.

⊕ Author information

Abstract

PURPOSE: We previously reported the functional and radiographic outcomes of 21 young adults at an average of 7 years after open reduction and internal fixation of an intra-articular distal radius fracture (original study). The purpose of the current investigation was to evaluate the same cohort at an average of 15 years after surgery to evaluate the effect of additional time on both function and radiographic appearance.

METHODS: We re-evaluated 16 of the original patients at an average of 15 years after surgery. Subjective assessment was performed with the Musculoskeletal Functional Assessment and the Hand Function Sort questionnaires. Objective assessment included a detailed physical examination and strength measurement. Standardized radiographs and computed tomography were used to assess wrist morphology, residual articular step and gap displacement, and the presence and degree of arthrosis.

RESULTS: Subjectively patients continued to function at a high level at the last follow-up evaluation: the average Musculoskeletal Functional Assessment score was 10 and 14 of the 16 patients functioned at a high level according to the Hand Function Sort. Strength and range of motion remained essentially unchanged from the original report. Radiocarpal arthrosis was noted in 13 of the 16 wrists and joint space was reduced an additional 67% compared with the 7-year follow-up evaluation. Nonetheless there continued to be no correlation between the presence or degree of arthrosis and upper-extremity function.

CONCLUSIONS: Radiocarpal arthrosis after intra-articular distal radius fractures can be expected to worsen over time. Despite joint space narrowing and evidence of advanced arthrosis, however, patients maintained a high level of function at the long-term follow-up evaluation.

TYPE OF STUDY/LEVEL OF EVIDENCE: Prognostic, Level II.

THANK YOU!

Complications

- Median nerve neuropathy (CTS) most frequent neurologic complication
- 1-12% in low energy fxs and 30% in high energy fxs
- prevent by avoiding immobilization in excessive wrist flexion and ulnar deviation (Cotton-Loder Position)
- treat with acute carpal tunnel release for:
 - progressive paresthesias, weakness in thumb opposition
 - paresthesias do not respond to reduction and last > 24-48 hours
- Ulnar nerve neuropathy seen with DRUJ injuries
- EPL rupture nondisplaced distal radial fractures have a higher rate of spontaneous rupture of the extensor pollicis longus tendon
 - extensor mechanism is felt to impinge on the tendon following a nondisplaced fracture and causes either a mechanical attrition of the tendon or a local area of ischemia in the tendon.
- treat with transfer of extensor indicis proprius to EPL
- Radiocarpal arthrosis (2-30%) 90% young adults will develop symptomatic arthrosis if articular stepoff > 1-2 mm
- may be asymptomatic

Complications (con't)

- Malunion and Nonunion Intra-articular malunion
 - treat with revision at > 6 weeks
- Extra-articular angulation malunion
 - treat with opening wedge osteotomy with ORIF and bone grafting
- Radial shortening malunion
 - radial shortening associated with greatest loss of wrist function and degenerative changes in extra-articular fxs
 - treat with ulnar shortening
- ECU or EDM entrapment entrapment in DRUJ injury
- Compartment syndrome RSD/CRPS AAOS 2010 clinical practice guidelines recommend vitamin C supplementation to prevent incidence of RSD postoperatively